801

PHYTOTOXICOLOGY ASSESSMENT SURVEYS CONDUCTED IN THE VICINITY OF THE IVACO METAL RECYCLING PLANT, LONGUEUIL TOWNSHIP MAY, 1986 THROUGH JANUARY, 1988

FEBRUARY 1990

Ontario
Environment
Environnement
Jim Bradley, Minister/ministre

ISBN 0-7729-5089-X

91-05297/

PHYTOTOXICOLOGY ASSESSMENT SURVEYS CONDUCTED IN THE VICINITY OF THE IVACO METAL RECYCLING PLANT, LONGUEUIL TOWNSHIP MAY, 1986 THROUGH JANUARY, 1988

Report prepared by:
R. N. Emerson

ARB-114-88-Phyto

FEBRUARY 1990

RECYCLABLE

Copyright: Queen's Printer for Ontario, 1990
This publication may be reproduced for non-commercial purposes with appropriate attribution.

TABLE OF CONTENTS

	Page
EXECUTIVE SUMMARY	1
DESCRIPTION OF SURVEY AND SAMPLING PROGRAM	2
Moss Bag Surveys	2
Maple Foliage Collection	2
Soil Collection Program	3
Field Crops Sampling Program	4
SAMPLE PROCESSING AND ANALYSIS	4
ANALYTICAL RESULTS	5
Moss Bag Results	5
Maple Foliage Results	7
Soil Metal Results for Residential Sites	8
Metal Results for Farm Properties	11
SUMMARY	13
Moss Bags	13
Vegetation	13
Soil	13
CONCLUSION	14
TABLES	
FIGURES	

EXECUTIVE SUMMARY

Vegetation and soil sampling programs have been conducted by the Phytotoxicology Section in the vicinity of IVACO since 1980. More recently, in 1987, soil was collected from residential and farm properties and field crops were sampled in response to public concern as to the effects of metal emissions from IVACO on residential and farm properties in the area. Prior to 1987, tree foliage and soil sampling was performed primarily at residential sites. In addition, 3 moss bag surveys have been conducted since May 1984, with the latest moss survey extending through to early January 1988.

The results of the more recent Phytotoxicology surveys conducted since May 1986 are presented in this report. The earlier results have been previously reported.

The metal results for the moss bag, vegetation and soil sampling programs which have been conducted since 1980, indicate that IVACO operations are a source of atmospheric metal emissions and that Cr and Fe are the primary metal elements being emitted. However, on the basis of the metal results for all vegetation and soil collection programs which have been undertaken by the Phytotoxicology Section, it is concluded that current and historical metal emissions from the IVACO plant have resulted in only very minor elevations of contaminant levels in vegetation and soil within the survey area.

Phytotoxicology Assessment Surveys Conducted in the Vicinity of the IVACO Metal Recycling Plant, L'Orignal - May 1986 Through January 1988

DESCRIPTION OF SURVEY AND SAMPLING PROGRAM

Moss Bag Surveys

(May, 1986 - April 1987; July, 1987 - January, 1988)

Two moss bag surveys have been conducted in the vicinity of IVACO subsequent to the initial moss bag survey in 1984-1985 (October through April) (ARB-82-86-Phyto). In May, 1986, the 1984-85 moss bag survey, which consisted of 6 sites, was expanded to 12 sites which were situated at increasing distance to the N, S, E and W of IVACO (see attached Figure 1). At each site, a single moss bag was placed at a height of about 3m (10') on a telephone or hydro pole. The moss bags were replaced approximately every 30 days through April, 1987. This 11 month survey was conducted to determine the status of IVACO emissions during the winter versus summer/fall months.

Another moss bag survey, consisting of seven sites (Sites 1, 2, 3, 7, 8, 9 and 10; Figure 1) also was conducted between July, 1987 and early January, 1988. This survey augmented the MOE Southeast Region's ambient air monitoring program in the vicinity of IVACO.

The monthly moss bag exchanges were conducted by Mr. G. Murphy, MOE, Cornwall who requested the surveys. All bags were subsequently forwarded to the Phytotoxicology Section for processing.

Maple Foliage Collection

(August 1986)

In late August, 1986, maple foliage was collected in the vicinity of moss bag Sites 1, 2, 3, 7, 8, and 12. Foliage sampling in the IVACO

survey area also had been performed by the Phytotoxicology Section in 1980, 1981, 1983 and 1984.

Soil Collection Program

(August 31 - September 2, 1987)

In addition, during August 31 - September 2, 1987, soil was collected from several residential and farm properties in the immediate vicinity of IVACO and at more remote locations.

The soil collection program in 1987 was of much larger scale than the earlier (1980 and 1984) soil sampling programs which excluded farm properties. The more recent soil sampling was conducted in response to public concern as to the effects of metal emissions from IVACO on residential and farm properties in the area. Some area residents have expressed concern that soil metal contamination may be threatening water supplies.

Soil Sampling at Residential Sites

During August 31 - September 2, 1987, soil was collected from 24 residential properties, including a park (Site 12) and school property (Site 24), to the neighbouring W, N, E and S of IVACO. Four remote residential sites also were sampled. At all sites, surface soil was sampled from an exposed lawn area to a 5 cm depth. At 11 sites, soil at a depth of 10 - 15 cm (in one case, 15 - 20 cm) additionally was collected. It was not possible to sample the subsoil at most sites due to hardpacked and/or stony soil conditions. Garden soil additionally was collected from 13 residential properties, including two remote gardens, at usual tilled depth (0-15 cm) (see Table 7 and Figure 2).

Soil Sampling on Farm Properties

Also during August 31 - September 2, 1987, field soil from 5 hay field sites (Sites 31, 34, 35, 36, 38) and from 3 grain field sites (Sites

13, 14, 40), including a corn field (Site 40), was collected from farm properties which were closest to IVACO. A remote hay field (Site 37) and corn field (Site 41) also were sampled. At all field sites, the soil samples were collected at usual tilled depth (0-15 cm) (see Table 9 and Figure 2).

Field Crops Sampling Program

(August 31 - September 2, 1987)

During August 31 - September 2, 1987, samples of forage (grass and/or clover plants excluding roots) from 6 hay field sites (Sites 31, 33, 34, 35, 36, 38) additionally were collected in the vicinity of IVACO (Table 9, Figure 2). Forage samples also were collected from a remote hay field (Site 37).

In addition, corn foliage was collected from the corn field (Site 40) closest to IVACO as well as from a remote corn field (Site 41). At both corn sites, exposed middle - upper leaves were collected from several mature corn plants.

SAMPLE PROCESSING AND ANALYSIS

All samples (moss, foliage, forage and soil) were initially processed in the Phytotoxicology Processing Laboratory. The samples then were submitted, on a dry weight basis, to the Inorganic Trace Contaminants Section, Laboratory Services Branch, MOE, to be analyzed for cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), molybdenum (Mo), nickel (Ni), vanadium (V) and zinc (Zn).

ANALYTICAL RESULTS

Moss Bag Results

May 1986 through April 1987 Moss Bag Survey

The metal concentrations detected at each of the 12 moss bag sites (Figure 1) between May, 1986 and April, 1987 have been summarized in attached Table 1. This table shows the concentration range and mean for each metal at all sites for the mid-May through Mid-November (1986) summer/fall period, and for the mid-November, 1986 through mid-April, 1987 winter period. Also shown are the number of times (30 day exposures) that the actual metal concentrations detected at each site during the summer/fall versus winter period were in excess of the rural and/or urban Upper Limit of Normal guidelines developed by the Phytotoxicology Section. Although the actual exposure dates for the 2 seasonal categories (summer/fall vs. winter do not completely align with the calendar dates for the 4 seasons, they were described in this way to enable a simple comparison of moss bag accumulations during the time of year when most vegetation would be exposed compared to the time of the year when vegetation is either dormant or non-existent.

Table 1 shows that the moss bag concentration means for all metals (Cd, Cr, Cu, Fe, Pb, Mo, V and Zn) except nickel generally were higher at sites in the immediate vicinity of IVACO than at remote sites. The highest metal concentrations usually were detected at moss Sites 3 (S perimeter of IVACO) or 9 (near NW corner), with the levels detected at moss Sites 1 (near NE corner) and 7(N perimeter), on several occasions, also tending to be higher than at other sites.

Moss bag metal concentration means were found to be generally more elevated during the summer/fall (May - November) period. There also were a greater number of exceedances of the rural and/or urban guidelines during the summer/fall than during the winter period (November - April).

Table 2 shows all sites where, at the end of each monthly exposure period (May, 1986 - April, 1987), metal concentrations in moss were found to be in excess of the rural and/or urban guidelines. Upper Limit of Normal moss guidelines have been developed for all but two (Mo and V) of the metals. In the case of Cr, only an urban guideline has been developed.

As shown in Table 2, the rural Upper Limit of Normal guidelines for Cu, Fe, Pb, and Zn and the urban Cr guideline were exceeded on a regular basis, with all elevated Cr and Fe levels and most of the elevated Cu and Zn levels being confined to moss sites in the immediate area of IVACO. Moss bag Pb levels also were found to be elevated at remote sites during each exposure indicating that vehicle emissions have contributed to the elevated Pb levels found in moss throughout the survey area.

A comparison of the monthly moss bag results to the urban guidelines revealed that only the higher levels of Cr (8 - 30 ppm) and Fe (3,100 - 4,900 ppm) were in excess of the respective guidelines. The 7 ppm Cr guideline was exceeded at Sites 1, 3, 7, and/or 9 during most exposure periods, whereas the urban Fe guideline of 3,000 ppm was exceeded at only one or two sites (Site 3 or 9) during 4 of the 11 exposure periods. The fact that Cr and Fe were the only elements to exceed the urban guidelines indicates that these are the primary elements being emitted by IVACO operations (see Table 2).

During the earlier October, 1984 through April, 1985 moss bag survey, the higher Cr (10 - 18 ppm) and Fe (4,600 - 4,400 ppm) levels, as well as a few elevated zinc levels (810 - 1,300 ppm), were found to exceed the respective urban guidelines. A comparison of the more recent moss bag data to the corresponding 1984 - 85 (Oct. - Apr.) data revealed that moss bag concentrations of most elements (Cd, Cr, Cu, Fe, Pb, Mo, Zn) generally were reduced in 1986 - 87. During October, 1986 through April, 1987, there also were fewer exceedances of the guidelines compared to the number of exceedances recorded during the same 6 month period in 1984 - 85 (see Table 3).

<u>July 1987 through January 1988 Moss Bag Survey</u>

This moss bag survey, which augmented the MOE air monitoring program, consisted of 7 sites (Sites 1, 2, 3, 7, 8, 9 and 10) all of which were in the immediate area of IVACO with exception of remote Site 10. All

moss bag exposure periods were approximately 30 days with exception of the final exposure (Nov 27 - Jan 7, 1988) which ran for 41 days.

As shown in Table 4, during July, 1987 through early January, 1988, the higher metal concentrations generally were confined to moss Sites 1, 3, 7 and/or 9, with the highest levels of most metals (Cd, Cr, Fe, Pb, V and Zn) usually being detected at Site 3 on the S perimeter of IVACO. The higher Cr, Cu, Fe, Pb and Zn concentrations detected at the end of each exposure period were in excess of the respective rural guidelines (in the case of Cr, the urban guideline). In addition, the rural guideline for Ni was exceeded at Site 3 on two occasions. Table 4 also shows that the higher Mo levels of 6.2 and 8.0 ppm were elevated in relation to the highest background level (3.6 ppm) that was detected at remote Site 10.

However, in comparing the monthly metal results to the moss bag guidelines for an urban area, only the higher Cr (8 - 25 ppm) and Fe (3,200 - 4,400) levels were found to be in excess of the respective (7 ppm and 3,000 ppm) guidelines. The highest moss bag concentrations of Cr (25 ppm) and Fe (4,400 ppm) were detected during the final exposure period (Nov. 27, 1987 - January 7, 1988) which was 41 days. The Upper Limit of Normal guidelines are based on a 30 day exposure; therefore, the November - January data should not be directly compared to the other moss bag results nor to the Upper Limit of Normal guidelines.

As shown in Table 5, the July through November, 1987 moss bag metal results were, with only a few minor exceptions (possibly due to variations in wind direction), fairly similar to the corresponding 1986 results.

Maple Foliage Results

The metal results for the maple foliage samples collected in the vicinity of moss bag Sites 1, 2, 3, 7, 8 and 12, all of which were neighbouring IVACO, are shown in attached Table 6.

All foliage sites but two (Sites 8 & 12) were sampled in previous years (1980-84). The foliar site numbers cited in the following paragraphs correspond with the moss bag sites (see Figure 1).

As shown in Table 6, the higher foliar metal concentrations, in most cases, were detected at either Site 1 (NE corner), Site 3 (S perimeter) or Site 7 (near N perimeter). In previous reports, these would be foliage Sites 6, 11 and 1, respectively.

However, in comparing the foliar results to the Phytotoxicology Section Upper Limit of Normal guidelines for a rural area, only the foliar iron concentrations detected at Sites 1 (655 ppm), 3 (550 ppm) and 8 (510 ppm) were found to be slightly greater than the respective 500 ppm rural guideline. None of the foliar results, including the higher Fe levels, were in excess of the urban guidelines.

Slightly elevated foliar iron levels also were documented at three sites in 1984 and at two sites in 1983 and 1980. In previous years, none of the other elements were found to be excessive with exception of zinc at one site in 1983. The foliar metal concentrations detected at Sites 1, 2, 3 and 7 were, in most cases, slightly lower than the 1984 results, but generally the 1986 results were not markedly different from the earlier years' (1980 - 1984) foliar data.

Soil Metal Results for Residential Sites

Lawn Surface Soil (0 - 5cm)

As shown in Table 7, soil collection sites (shown in Figure 2) in the immediate area of IVACO tended to have slightly higher concentrations of Cd, Cr, Fe, Pb, V and Zn than sites farther away, with the Cu, Mo, and Ni results being similar to those found at remote soil sites. However, comparisons to the Upper Limit of Normal rural guidelines revealed that only the higher soil concentrations of Cr (52 - 110 ppm), Fe (35,500 - 38,500) and V (72 - 84 ppm) were in excess of the

respective guidelines (50 ppm Cr, 35,000 ppm Fe, 70 ppm V). It should be noted that even the higher Cr (60 - 88 ppm) and V (71 ppm) levels found at remote sites were above the respective (50 and 70 ppm) rural guidelines.

In lawn surface soil (0-5 cm), the higher Fe and V levels were confined to only some sites while soil levels of Cr were elevated (> 50 ppm) at several (15) of the 28 collection sites. The fact that soil Cr levels of greater than the 50 ppm rural guideline were detected at 2 of the 4 remote sites suggests that background Cr levels in the area may be naturally elevated. The fact that the initial control site sampled in 1980 also had a slightly elevated Cr level (66 ppm) would further support this belief. Regardless, it is likely that IVACO emissions of Cr have contributed to the elevated soil Cr levels found in the immediate area of the company.

Soil clean-up or decommissioning guidelines for all metals but Fe also have been developed by the Phytotoxicology Section. No decommissioning guideline has been established for Fe as this element is naturally high and variable in soil. These guidelines were developed for the decommissioning of industrial-commercial land for residential and park use. Soil concentrations below these guidelines would not be expected to be phytotoxic or pose any threat to animal or human health. In comparing the soil results to these guidelines, it is apparent that even the highest metal levels which were found in surface soil (0 - 5 cm) are of no immediate concern. (see Table 7).

Seven of the 28 collection sites also were sampled in 1984 and/or 1980 and, as shown in Table 8, there were a few sites where the metal content of the surface soil (0 - 5 cm) would appear to have slightly increased since 1980. However, the slight differences could be due to natural sampling and analytical variability. Overall, the soil metal levels detected in 1987 were not markedly different from the earlier years' results.

Lawn Subsoil

Subsoil from 11 residential lawn sites, including 2 remote sites, additionally was collected at a depth of 10 - 15 cm (in one case, 15 - 20 cm depth).

Table 7 shows that, in most cases, the subsoil had slightly higher levels of Cr, Cu, Fe, Ni and V than surface soil. However, this would appear to be normal for these elements as a similar pattern was found at remote sites. The Cd, Pb and Zn data for most sites displayed an opposite pattern (indicative of atmospheric deposition) while the Mo levels detected in the surface and subsoil at all sites were similar (< 1 ppm).

The subsoil metal results for sites in the immediate vicinity of IVACO were not markedly different from the remote (control) data. As in surface soil, the metal concentrations detected in subsoil throughout the survey area generally were low relative to the soil decommissioning guidelines (see Table 7).

Garden Soil (0-15 cm)

In garden soil (0 - 15 cm), only the higher soil levels (means) of Cd (4.4 ppm - Site 26); Cr (99 ppm - Site 11, 105 ppm - Site 15, 76 ppm - Site 22); Fe (39,500 ppm - Site 15); Pb (286 ppm - Site 16, 290 ppm - Site 22, 205 ppm - Site 25) and V (77 ppm - Site 15), which were found at the stated sites, exceeded the Upper Limit of Normal rural guidelines for surface soil (0 - 5 cm). However, all garden soil metal results, including the higher Cr and Pb levels, were well below the soil decommissioning guidelines with the exception of the 4.4 ppm Cd mean for Site 26 which slightly exceeded the respective 4 ppm decommissioning guideline (see Table 7). On the basis that the backyard lawn sampled adjacent to the garden at Site 26 had low soil Cd levels (0.7 and 0.9 ppm), as did all other garden and lawn collection sites, it is suspected that the Site 26 garden was amended with soil and/or other material which contained elevated Cd levels. It is not

suspected that IVACO emissions are responsible, as Phytotoxicology studies to date do not indicate that IVACO operations are a significant emitter of Cd.

Metal Results for Farm Properties

Field Soil Results

The 5 hay field soil sites (Sites 31, 34, 35, 36, 38) sampled in the vicinity of IVACO were close to the company's south and west property boundaries (see Figure 2).

As shown in Table 9, the highest soil levels of most metals were found at field Sites 34 and 35 which neighboured IVACO's south property limit and main entrance.

Compared to the Phytotoxicology Section rural guidelines for surface soil (0 - 5 cm), soil levels of Cr, Fe and V at all hay field sites, including the remote site, appeared to be elevated. However, relative to the soil decommissioning guidelines, all field soil results, including the highest Cr (145 ppm) and V (103 ppm) levels, generally were of no immediate concern.

Also, during August 31 - September 2, soil was collected at usual tilled depth (0 - 15 cm) from an oat/barley field (Sites 13 and 14) to the immediate N of IVACO, from a corn field (Site 40) to the S, and from a remote corn field (Site 41) (see Figure 2).

Even the highest grain field soil metal levels, which were detected in the oat/barley field (Sites 13 & 14), were not found to be excessive compared to the Upper Limit of Normal surface soil (0 - 5 cm) guidelines and to the soil decommissioning guidelines.

Forage/Corn Foliage Results

Forage (grass and/or clover plants) from all previously noted hay field sites and from Site 33, in addition to corn foliage from Sites 40 and 41, also was collected for analysis. The corresponding results are presented in Table 9.

In forage grasses, the highest metal concentrations usually were detected at Site 35, just S of the entrance to IVACO (see Figure 2).

Upper Limit of Normal guidelines have been established for metals in forage grass (no guidelines have been developed by the Phytotoxicology Section for clover or corn foliage) and comparisons revealed that only zinc at one grass site (52 ppm - Site 35) was slightly elevated compared to the respective 40 ppm Zn guideline.

The clover plants collected in the immediate vicinity of IVACO also contained generally higher metal levels than plants from remote areas. The Fe (245 ppm), Pb (5 ppm) and Zn (72 ppm) levels detected at Site 35 were the most elevated in relation to the respective control results (49 ppm Fe, 1 ppm Pb, 28 ppm Zn). However, considering that the higher plant levels of Fe and Pb were well below the forage grass guidelines (500 ppm Fe, 20 ppm Pb) and that the highest Zn level of 72 ppm was only marginally higher than the 40 ppm grass guideline, none of the metal levels found in the clover samples would appear to be excessively elevated.

Metal levels detected in the corn foliage samples collected from the corn field (Site 40) closest to IVACO (this site was about 600m S of forage Site 35) also were not considered to be excessively elevated based on comparisons to the control (Site 41) data.

The metal levels detected in the grass, clover and corn foliage samples would not be expected to pose a threat to livestock health since even the higher metal levels found in the forage and corn foliage samples generally were low relative to dietary metal levels tolerable by livestock (see Table 10).

SUMMARY

Moss Bags

The moss bag surveys conducted since 1984 revealed that IVACO metal recycling operations are a source of several metals - Cd, Cr, Cu, Fe, Pb, Mo, Ni, V and Zn. The more recent data revealed that the highest levels of most metals were above the Upper Limit of Normal rural guidelines but that only the highest levels of Cr and Fe were in excess of the urban guidelines. The May, 1986 through April, 1987 data indicated that IVACO operations are a more significant source of metal emissions during the summer/fall than during the winter.

Vegetation

In the maple foliage samples collected in August, 1986, only Fe at 3 sites was found to be slightly elevated compared to the Upper Limit of Normal rural guidelines. All 1986 and earlier years' maple foliage results did not exceed the urban guidelines.

The metal results for the forage (grass, clover) and corn foliage samples collected in 1987 also were not found to be excessively elevated. Comparison of the grass results to the respective Upper Limit of Normal guidelines revealed that only Zn at one site was slightly elevated.

Soil

In lawn surface soil (0 - 5 cm), only the higher Cr, Fe and V levels found in the survey area were in excess of the respective Upper Limit of Normal guidelines and it is likely that emissions from IVACO have contributed to the elevated soil metals levels found in the immediate area of the company.

Metal levels in lawn subsoil (10 - 15 cm) were fairly similar, for the most part, to the corresponding surface soil results. However, in comparing the metal results for the lawn sites to the soil decommissioning guidelines, even the highest metal levels found in the surface and subsoil were of no immediate concern.

The soil (0 - 15 cm) metal results for all garden, hay field and corn field sites sampled in 1987 also were below the respective soil decommissioning guidelines with exception of the Cd mean for garden Site 26. However, it is not suspected that the Cd found in this garden was related to IVACO emissions, as Phytotoxicology studies to date do not indicate that IVACO is a significant emitter of Cd.

CONCLUSION

In conclusion, the moss bag, vegetation and soil sampling programs which have been conducted in the vicinity of IVACO since 1980 confirm that IVACO operations are a source of atmospheric metal emissions. The monthly moss bag data alone indicate that Cr and Fe are the primary elements being emitted; however, moss bag exceedances for Cu, Zn and to a lesser degree, Pb also were associated with proximity to the IVACO plant.

On the basis of the metal results for all vegetation (maple foliage, forage, corn foliage) and soil collection programs which have been undertaken by the Phytotoxicology Section, it can be concluded that current and historical metal emissions from the IVACO plant have resulted in only very minor elevations of contaminant levels in vegetation and soil within the survey area.

Table 1

Summary of Moss Bag Cadmium, Chromium, Copper and Iron

Results for May-November (Summer/Fall) Versus November-April (Winter)

Monthly Exposures - May 1986 Through April 1987

Site (See Figure 1)	Range (R) Mean (M) a Exceedances (E)	Concentration in Moss - parts per million, dry weight basis							
		Cadmium		Chromium		Copper		Iron	
		Summer/Fall	Winter	Summer/Fall	Winter	Summer/Fall	Winter	Summer/Fall	Winter
1	R M E	0.6-0.8 0.6 0	0.3-0.8 0.4 0	9-13 <u>10</u> (8)	9-15 8 (1)	7-9 8 3	5-7 7 1	1,600-3,000 <u>1,980</u> 6	1,100-2,400 1,840 1
2	R M E	0.4-0.6 0.5 0	0.3-0.5 0.4 0	6-9 7 (3)	4-5 4 (0)	6-10 8 3	6-10 7 1	1,300-2,100 1,866 2	1,300-1,600 1,390 0
3	R M E	0.6-1.2 0.7 0	0.2-1.0 0.7 0	8-21 <u>13</u> (8)	6-17 <u>10</u> (3)	8-13 <u>9</u> 3	7-10 8 2	1,300-3,700 <u>2,117</u> 3(1)	1,600-3,000 <u>2,240</u> 4
F 4	R M E	0.3-0.6 0.4 0	0.4-0.5 0.5 0	3-6 4 (0)	3-4 3 (0)	4-6 5 0	5-6 5 0	970-1,300 1,010 0	910-1,100 1,020 0
F 5	R M E	0.2-0.4 0.3 0	0.3-0.5 0.4 0	4-7 5 (0)	3-5 4 (0)	5-8 6 0	5-8 6 0	910-1,800 1,201 0	960-1,300 1,192 0
F 6	R M E	0.2-0.5 0.3 0	0.2-0.5 0.4 0	3-6 5 (0)	2-3 3 (0)	6-23 <u>13</u> 3	5-7 6 0	980-1,600 1,013 0	900- 1,400 1,084 0
7	R M E	0.4-0.7 0.5 0	0.3-0.6 0.4 0	4-24 <u>12</u> (5)	3-13 7 (2)	7-21 <u>13</u> 4	6-13 7 1	1,300-3,000 <u>2,017</u> 4	1,100-2,600 1,600 1
8	R M E	0.2-0.5 0.4 0	0.3-0.4 0.3 0	6-15 <u>9</u> (3)	2-6 4 (0)	6-9 7 3	4-7 6 0	1,300-1,700 1,493 0	920-1,600 1,116 0
9	R M E	0.6-0.9 0.8 0	0.9-1.1 1.1 1	9-19 <u>13</u> (5)	2-30 <u>13</u> (2)	12-40 <u>21</u> 6	9-26 <u>13</u> 3	2,200-3,200 <u>2,717</u> 6(3)	1,600-4,900 <u>2,900</u> 3(2)
F 10	R M E	0.3-0.5 0.4 0	0.3-0.4 0.4 0	4-6 5 (0)	2-4 3 (0)	5-7 6 0	4-6 5 0	940-1,300 1,157 0	880-1,300 1,094 0
F 11	R M E	0.2-0.4 0.3 0	0.3-0.7 0.4 0	3-5 4 (0)	2-4 3 (0)	5-9 6 1	5-6 5 0	780-1,300 968 0	880-1,100 984 0
12	R M E	0.3-0.8 0.5 0	0.3-0.6 0.5 0	6-15 <u>9</u> (3)	4-7 5 (0)	8-17 <u>9</u> 2	5-8 6 0	1,100-1,400 1,067 2	1,100-1,800 1,400 1
<u>U.S.*</u>	Rural Urban	2 4		9* 7		8 60		1,700 3,000	

* Upper Limit of Normal moss guidelines established by the Phytotoxicology Section

** No guideline established

a Number of occasions the moss concentration exceeded the Upper Limit of Normal guideline for a rural area (urban area)

F - Remote Site

Note: Means underlined exceed the rural guideline (with Cr, the urban guideline)

Table 1 (Cont'd): Summary of Moss Bag Lead, Molybdenum, Nickel, Vanadium and Zinc Results for May - November (Summer/Fall) Versus November - April (Winter) Monthly Exposures - May 1986 Through April 1987

Site (See Figure 1)	Range (R) Mean (M) Exceedances (E) [a]	Concentration in Moss - parts per million, dry weight basis									
		Lead		Molybdenum		Nickel		Vanadium		Zinc	
		Summer/Fall	Winter	Summer/Fall	Winter	Summer/Fall	Winter	Summer/Fall	Winter	Summer/Fall	Winter
1	R M E	26-55 42 5	28-59 40 3	0.8-1.4 1.1 **	<0.5-0.9 0.6 **	3-5 4 0	3-5 4 0	7-9 8 **	5-9 6 **	100-170 142 5	71-180 104 1
2	R M E	28-62 41 4	24-41 34 2	<0.5-2.0 1.0	<0.5-<0.5 <0.5	3-5 4 0	3-5 4 0	4-8 6	5-7 6	76-270 178 5	73-150 111 2
3	R M E	30-67 48 5	39-64 51 5	<0.5-1.8 1.0	<0.5-0.8 0.7	2-5 4 0	3-5 4 0	3-11 7	6-10 7	53-370 174 4	86-270 173 4
4[r]	R M E	21-38 29 1	27-43 33 1	<0.5-0.7 0.5	<0.5-<0.5 <0.5	2-4 3 0	3-12 6 1	3-7 5	5-6 6	33-130 67 1	53-79 64 0
5[r]	R M E	20-41 33 3	31-53 41 4	<0.5-0.8 0.6	<0.5-<0.5 <0.5	2-6 4 0	3-4 3 0	3-7 6	5-7 6	35-93 72 0	78-100 79 0
6[r]	R M E	30-55 42 4	37-50 45 5	<0.5-0.7 0.5	<0.5-<0.5 <0.5	2-4 3 0	3-4 3 0	3-7 5	5-7 6	38-71 55 0	62-75 69 0
7	R M E	33-58 43 4	27-47 34 2	<0.5-1.6 1.0	<0.5-0.7 0.5	3-7 5 1	3-4 4 0	5-9 8	5-10 7	70-210 115 3	58-110 81 1
8	R M E	20-42 33 3	23-39 32 2	<0.5-1.1 0.8	<0.5-<0.5 <0.5	3-5 4 0	3-4 3 0	6-8 7	5-6 5	59-91 69 0	48-100 66 0
9	R M E	40-71 56 6	26-140 64 4	<0.5-1.3 0.8	<0.5-1.0 0.8	3-5 4 0	3-7 5 1	8-9 9	5-10 8	120-270 198 6	74-590 261 4
10[r]	R M E	33-49 41 5	26-41 33 2	<0.5-0.8 0.7	<0.5-<0.5 <0.5	3-5 4 0	3-4 3 0	6-7 7	5-7 6	68-97 82 0	57-110 79 1
11[r]	R M E	24-40 32 2	26-41 34 2	<0.5-0.8 0.6	<0.5-<0.6 0.5	3-13 5 1	3-3 3 0	5-6 6	5-6 6	39-61 49 0	51-81 63 0
12	R M E	32-59 41 3	35-55 42 4	<0.5-1.6 0.8	<0.5-<0.6 0.5	2-5 4 0	3-3 3 0	4-9 7	5-6 6	61-180 116 4	89-130 105 2
ULN*	Rural Urban	35 200		** **		6 13		** **		100 800	

* Upper Limit of Normal Moss guidelines established by the Phytotoxicology Section
** No guideline established
a Number of occasions the moss concentration exceeded the Upper Limit of Normal guideline for a rural area (urban area)
r Remote site
Note: Means underlined exceed the rural guideline

BE/RE2707-TAB1A

Table 2
Moss Sites Where Metal Concentrations in Excess of the Respective Rural Guidelines Were Documented at the End of Each 30 Day Exposure Period - May 1986 through April 1987

Exposed Period	Sites where Exceedances were Found						
	Cd	Cr	Cu	Fe	Pb	Ni	Zn
May 13-Jun. 12/86	-	1*,2*,3*,7*,8*,9*,12*	1,2,3,6,8,9,11	1,3,9	1,3,6,8,9,10	7,11	1,2,3,9
Jun. 12-Jul. 11/86	-	1*,2*,3*,7*,8*,9*,12*	6,7,9,12	1,7,9*,12	3,5,6,7,9,12	-	1,2,3,7,9,12
Jul. 11-Aug. 8/86	-	1*,3*,7*,9*	1,9	1,7,9	1,2,3,5,7,8,9,10	-	1,9
Aug. 8-Sept. 8/86	-	1*,2*,3*,7*,8*,9*,12*	1,2,3,7,8,9,12	1,2,3,7,9,12	1,2,3,4,6,7,8,9,10,11,12	-	1,2,3,4,7,9,12
Sept. 8-Oct. 10/86	-	9*	7,9	2,9	1,2,7,9,10,11,12	-	2,7,9,12
Oct. 10-Nov. 12/86	-	1*,3*,7*,9*	2,3,6,7,9	1,3*,7,9*	1,2,3,5,6,7,9,10	-	1,2,3,9,12
Nov. 12-Dec. 16/87	-	1*,3*,7*,9*	1,2,3,7,9	1,3,7,9,12	1,2,3,5,6,7,8,9,10,11,12	-	1,2,3,7,9,12
Dec. 16-Jan. 19/87	-	-	-	-	3,5,6,9,11,12	-	3,9
Jan. 19-Feb. 16/87	-	3*	3,9	3,9*	1,2,3,4,5,6,9,12	4	3,9,12
Feb. 16-Mar. 18/87	-	-	-	3	1,3,5,6	-	3
Mar. 18-Apr. 15/87	9	3*,7*,9*	7,9	3,9*	3,6,7,8,9,10,12	9	2,9,10
ULN[a] Rural	2	b	8	1,700	35	6	100
Urban	4	7	60	3,000	200	13	800

a Phytotoxicology Section Upper Limit of Normal guidelines for rural and urban moss
b No rural guideline established
* Concentration exceeds urban guideline

RE2707-TAB2

TABLE 3

Moss Bag Cadmium, Chromium, Copper and Iron Results for October 1986 Through April 1987 Compared to the Corresponding 1984-85 Moss Bag Data

Site	Data Summary	Range (R) and Mean (M) of Moss Data (ppm, dry wt.)							
		Cadmium		Chromium		Copper		Iron	
		1986-87	1984-85	1986-87	1984-85	1986-87	1984-85	1986-87	1984-85
1	R	0.3-0.5	0.4-3.3	3-15	3-14	5-10	6-23	1,100-2,400	960-4,000
	M	0.4	1.1	6	8	7	12	1,617	2,026
	E[e]	0	1	2	3	1	4	1	2
2	R	0.3-0.5	0.3-1.0	4-6	4-10	6-10	12-19	1,200-1,700	1,100-2,400
	M	0.4	0.7	5	7	8	15	1,400	1,600
	E	0	0	0	1	2	5	0	1
3	R	0.2-1.0	1.2-3.0	6-22	6-18	7-13	9-20	1,500-3,700	1,600-4,400
	M	0.8	2.0	12	14	9	17	2,483	3,350
	E	0	2	4	5	3	6	5	5
r 4	R	0.4-0.5	0.3-0.5	3-4	2-3	4-6	4-8	910-1,200	850-1,100
	M	0.5	0.3	3	3	5	6	1,040	977
	E	0	0	0	0	0	0	0	0
r 5	R	0.3-0.5	0.3-0.6	3-5	3-4	5-8	6-14	960-1,400	1,000-1,300
	M	0.4	0.5	4	4	7	9	1,227	1,150
	E	0	0	0	0	0	2	0	0
r 6	R	0.2-0.5	0.3-0.5	2-4	2-3	5-11	6-9	900-1,400	800-1,000
	M	0.4	0.4	3	2	7	8	1,095	925
	E	0	0	0	0	1	1	0	0
ULN*	Rural	2		**		8		1,700	
	Urban	4		7		60		3,000	

* Phytotoxicology Section Upper Limit of Normal guidelines for rural and urban moss

** No guideline established

e Number of occasions the moss concentration exceeded the rural guideline (with chromium, the urban guideline)

r Remote site

Note: Means underlined exceed rural and/or urban guideline(s)

TABLE 3 (Cont'd)

Moss Bag Lead, Molybdenum, Nickel, Vanadium and Zinc Results for October 1986 Through April 1987
Compared to the Corresponding 1984-85 Moss Bag Data

Site	Data Summary	Range (R) and Mean (M) of Moss Data (ppm, dry wt.)									
		Lead		Molybdenum		Nickel		Vanadium		Zinc	
		1986-87	1984-85	1986-87	1984-85	1986-87	1984-85	1986-87	1984-85	1986-87	1984-85
1	R	28-59	27-180	<0.5-1.0	0.5-5.0	3-5	2-5	5-9	3-6	71-180	38-1,300
	M	39	60	0.7	1.9	4	3	7	4	109	321
	E[e]	4	3	**	**	0	0	**	**	2	5
2	R	24-46	22-64	<0.5-0.8	<0.5-1.5	3-5	2-4	5-7	3-5	73-270	66-350
	M	36	43	0.6	0.9	4	3	6	4	138	223
	E	3	4			0	0			3	4
3	R	39-67	64-190	<0.5-0.8	0.9-1.9	3-5	2-5	6-11	3-6	86-370	310-810
	M	54	105	0.6	1.5	4	3	8	5	206	510
	E	6	6			0	0			5	6
4[r]	R	27-43	14-28	<0.5-<0.5	<0.5-0.6	3-12	1-2	5-6	3-3	53-79	30-48
	M	33	21	<0.5	0.5	5	2	6	3	63	41
	E	1	0			1	0			0	0
5[r]	R	31-53	24-65	<0.5-<0.5	<0.5-0.8	3-5	2-3	5-7	3-6	78-100	42-120
	M	41	42	<0.5	0.3	4	2	6	4	82	68
	E	5	4			0	0			0	1
6[r]	R	37-50	29-51	<0.5-0.7	<0.5-0.7	3-4	2-3	5-7	3-4	62-75	29-48
	M	44	36	0.5	0.5	3	2	6	3	68	40
	E	6	2			0	0			0	0
ULN*	Rural	35		**		6		**		100	
	Urban	200		**		13		**		800	

* Phytotoxicology Section Upper Limit of Normal guidelines for rural and urban moss

** No guideline established

e Number of occasions the moss concentration exceeded the rural guideline

r Remote site

Note: Means underlined exceed rural and/or urban guideline(s)

BE/RF2707-TAB3.1

TABLE 4

Moss Bag Metal Concentrations

Detected Between July 22, 1987 and January 7, 1988

1st Exposure July 22 - August 24, 1987 (32 days)

Site	Cd	Cr	Cu	Fe	Pb	Mo	Ni	V	Zn
1	0.3	9	7	1,400	31	0.5	3	7	110
2	0.4	9	7	1,500	27	<0.5	3	7	190
3	1.1	23	15	3,500	74	8.0	7	9	460
7	0.4	12	10	2,000	41	1.6	3	8	85
8	0.3	6	6	1,200	30	<0.5	3	6	49
9	0.2	7	7	1,100	23	<0.5	3	6	110
10[r]	0.2	4	5	760	23	<0.5	4	5	59

2nd Exposure August 24 - September 29, 1987 (35 days)

Site	Cd	Cr	Cu	Fe	Pb	Mo	Ni	V	Zn
1	0.7	17	11	2,800	57	6.2	6	9	220
2	0.7	15	11	2,400	52	2.0	5	9	340
3	0.9	19	12	3,200	65	3.6	5	10	440
7	0.4	12	17	2,100	35	0.6	6	8	130
8	0.3	7	7	1,600	38	0.7	4	6	75
9	0.7	14	13	2,400	57	1.5	4	8	320
10[r]	0.4	5	6	980	45	<0.5	5	5	110

3rd Exposure September 29 - October 29, 1987 (30 days)

Site	Cd	Cr	Cu	Fe	Pb	Mo	Ni	V	Zn
1	0.7	11	8	2,100	46	1.8	4	8	240
2	0.5	5	6	1,400	34	1.1	3	6	100
3	0.4	8	9	1,800	38	1.4	3	7	110
7	0.5	11	14	2,100	39	2.5	3	8	180
8	0.4	11	8	2,000	31	0.5	3	10	76
9	0.6	8	8	1,900	38	0.6	3	8	180
10[r]	0.5	4	5	1,100	35	<0.5	3	6	91

Cont'd

TABLE 4 (Cont'd)

4th Exposure October 29 - November 27, 1987 (28 days)

Site	Cd	Cr	Cu	Fe	Pb	Mo	Ni	V	Zn
1	0.8	12	10	2,100	46	1.4	4	7	270
2	0.6	8	7	1,800	40	0.9	3	7	170
3	1.1	15	11	2,500	66	2.8	5	8	440
7	0.4	6	7	1,700	28	1.4	4	6	100
8	0.4	4	6	1,500	32	0.7	3	6	70
9	0.5	6	9	1,500	33	1.6	3	6	140
10[r]	0.4	4	6	1,000	30	3.6	3	5	99

5th Exposure November 27, 1987 - January 7, 1988 (41 days)

Site	Cd	Cr	Cu	Fe	Pb	Mo	Ni	V	Zn
1	0.6	9	9	1,800	45	0.9	4	6	200
2	0.6	9	8	1,600	40	0.6	4	5	200
3	1.0	14	11	2,300	51	1.3	4	5	330
7	-	-	-	-	-	-	-	-	-
8	0.3	4	6	950	29	<0.5	3	3	63
9	1.9	25	21	4,400	100	2.0	7	8	720
10[r]	0.5	5	7	1,200	39	<0.5	3	5	120

ULN Guidelines*

Rural	2	**	8	1,700	35	**	6	**	100
Urban	4	7	60	3,000	200	**	13	**	800

* Phytotoxicology Section Upper Limit of Normal guidelines for rural and urban moss

** No guideline established

r - remote site

Note: Results underlined exceed the rural and/or urban guideline(s).

TABLE 5

Moss Bag Cadmium, Chromium, Copper, and Iron Results for July through November 1987 Compared to the Corresponding 1986 Moss Bag Data

Site	Data Summary	Range (R) and Mean (M) of Moss Data (ppm, dry wt.)							
		Cadmium		Chromium		Copper		Iron	
		1987	1986	1987	1986	1987	1986	1987	1986
1	R M E[e]	0.3-0.8 0.6 0	0.5-0.6 0.6 0	9 - 17 12 4	5 - 12 9 3	7 - 11 9 2	7 - 9 8 2	1,400-2,800 2,100 3	1,600-2,000 1,850 3
2	R M E	0.4-0.7 0.6 0	0.4-0.5 0.5 0	5 - 15 9 3	6 - 9 7 1	6 - 11 8 1	6 - 10 8 1	1,400-2,400 1,775 2	1,200-2,100 1,700 2
3	R M E	0.4-1.1 0.9 0	0.4-1.2 0.6 0	8 - 23 16 4	5 - 22 11 3	9 - 15 12 4	5 - 13 8 2	1,800-3,500 2,750 4(2)	1,300-3,700 2,150 2(1)
7	R M E	0.4-0.5 0.4 0	0.5-0.5 0.5 0	6 - 12 10 3	4 - 16 11 3	7 - 17 12 3	7 - 21 12 3	1,700-2,100 1,975 3	1,400-2,200 1,950 3
8	R M E	0.3-0.4 0.4 0	0.2-0.5 0.4 0	4 - 11 7 1	6 - 8 7 1	6 - 8 7 0	5 - 9 6 1	1,200-2,000 1,575 1	1,200-1,500 1,350 0
9	R M E	0.2-0.7 0.5 0	0.6-0.9 0.8 0	6 - 14 9 2	9 - 17 15 4	7 - 13 9 2	12 - 40 21 4	1,100-2,400 1,725 2	2,200-3,100 2,525 4(1)
10[r]	R M E	0.2-0.5 0.4 0	0.3-0.5 0.4 0	4 - 5 4 0	4 - 6 5 0	5 - 6 6 0	5 - 7 6 0	760-1,100 960 0	1,100-1,300 1,225 0
ULN *	Rural	2		**		8		1,700	
	Urban	4		7		60		3,000	

* Phytotoxicology Section Upper Limit of Normal guidelines for rural and urban moss.

** No guideline established

e Number of occasions the moss concentration exceeded the rural guideline (with chromium, the urban guideline)

r Remote site

Note: Means underlined exceed the rural guideline (with Cr, the urban guideline).

Cont'd

TABLE 5 - Cont'd
Moss Bag Lead, Molybdenum, Nickel, Vanadium and Zinc Results for July through November 1987
Compared to the Corresponding 1986 Moss Bag Data

Site	Data Summary	Range (R) and Mean (M) of Moss Data (ppm, dry wt)									
		Lead		Molybdenum		Nickel		Vanadium		Zinc	
		1987	1986	1987	1986	1987	1986	1987	1986	1987	1986
1	R M E[e]	31-57 45 3	36-55 45 4	0.5-6.2 2.2 **	1.0-1.4 1.2 **	4 - 6 4 0	3 - 5 4 0	7 - 9 8 **	7 - 8 7 **	110-270 210 4	100-160 133 3
2	R M E	27-52 38 2	36-62 46 4	<0.5-2.0 1.0	0.7-2.0 1.2	3 - 5 4 0	3 - 4 4 0	6 - 9 7	4 - 8 6	100-340 200 3	76-270 182 3
3	R M E	38-74 61 4	30-67 47 3	1.3-8.0 3.4	<0.5-1.8 0.9	3 - 7 5 1	2 - 5 4 0	7 - 10 9	3 - 11 7	110-460 363 4	53-370 164 2
7	R M E	28-41 36 2	35-58 44 3	0.6-2.5 1.5	0.8-1.6 1.2	3 - 6 4 0	3 - 5 4 0	6 - 8 8	7 - 9 8	85-180 124 2	94-110 102 2
8	R M E	30-38 33 1	27-42 35 2	<0.5-0.7 0.6	0.7-1.1 0.8	3 - 4 3 0	3 - 4 3 0	6 - 10 7	6 - 7 7	49-76 68 0	59-91 69 0
9	R M E	23-57 38 2	50-71 59 4	<0.5-2.0 1.2	0.5-1.3 0.8	3 - 4 3 0	4 - 5 4 0	6 - 8 7	8 - 9 9	110-320 188 4	120-270 193 4
10[r]	R M E	23-45 33 1	38-49 42 4	<0.5-3.6 1.1	0.6-0.8 0.8	3 - 5 4 0	3 - 5 4 0	5 - 6 5	6 - 7 7	59-110 90 1	69-97 81 0
ULN *	Rural	35		**		6		**		100	
	Urban	200		**		13		**		800	

* Phytotoxicology Section Upper Limit of Normal guidelines for rural and urban moss.
** No guideline established
e Number of occasions the moss concentration exceeded the rural guideline (with chromium, the urban guideline)
r Remote site
Note: Means underlined exceed the rural guideline

TABLE 6
Metal Results for Maple Foliage Collected in the Vicinity of IVACO in August 1986 Compared to Earlier Years' Results

Foliage Sites*		Average Concentration in Unwashed Maple Foliage (ppm. dry wt)																	
Site No. in 1986	Site No. in earlier reports	Cadmium				Chromium					Copper				Iron				
		c 1986	c 1984	b 1983	b 1980	c 1986	c 1984	b 1983	d 1981	b 1980	c 1986	c 1984	b 1983	b 1980	c 1986	c 1984	b 1983	d 1981	b 1980
1(NE)	6	0.2	0.2	0.1	0.4	4	5	3	<2	3	7	8	8	7	655	640	520	250	402
2(E)	9	0.1	0.2	<0.1	<0.2	2	3	2	<2	2	5	7	7	5	255	350	217	160	302
3(S)	11	0.3	0.3	0.5	0.5	3	4	4	<2	4	8	11	11	9	550	725	717	420	638
7(N)	1	0.3	0.2	-	0.3	3	5	-	-	3	5	7	-	5	430	765	-	-	352
8(NW)	-	<0.1	-	-	-	2	-	-	-	-	10	-	-	-	510	-	-	-	-
12(SE)	-	0.2	-	-	-	3	-	-	-	-	4	-	-	-	325	-	-	-	-
ULN**		Rural 1				8					20				500				
		Urban 3				8					20				1,000				

Site No. in 1986	Site No. in earlier reports	Lead					Molybdenum		Nickel				Vanadium		Zinc				
		c 1986	c 1984	b 1983	d 1981	b 1980	c 1986	c 1984	c 1986	c 1984	b 1983	b 1980	c 1986	c 1984	c 1986	c 1984	b 1983	d 1981	b 1980
1(NE)	6	12	12	14	11	21	1.1	0.9	2	2	1	<1.0	<1	<1	68	35	57	31	57
2(E)	9	6	8	8	6	13	0.8	1.0	1	<1	<1	<1.0	<1	<1	41	44	39	27	46
3(S)	11	13	21	38	17	30	0.5	0.7	1	<1	2	1.8	<1	<1	93	115	300	88	118
7(N)	1	7	13	-	-	11	1.3	1.5	2	1	-	<1.0	<1	1	33	45	-	-	47
8(NW)	-	5	-	-	-	-	<0.5	-	1	-	-	-	<1	-	46	-	-	-	-
12(SE)	-	9	-	-	-	-	0.8	-	2	-	-	-	<1	-	50	-	-	-	-
ULN**		Rural 30					1.5		5				5		250				
		Urban 60					1.5		7				5		250				

* Foliage site numbers for 1986 correspond with the 1986-87 moss bag site numbers (Figure 1).
** Phytotoxicology Section Upper Limit of Normal guidelines for rural and urban foliage.
b Mean of triplicate results. c Mean of duplicate results. d Based on a single sample.
Note: Results underlined exceed the rural guideline.

TABLE 7

Soil Metal Concentrations Detected at Residential Sites in the Vicinity of IVACO and Nova Scotia - August 31 - September 2, 1977

Site-Property	Area* Sampled	Average** Concentration in Soil (ppm, dry weight basis)								
		Cd	Cr	Cu	Fe	Pb	Mo	Ni	V	Zn
		Properties Sampled in the Vicinity of IVACO								
1 (Res)	Lawn	0.4	25	9	12,900	21	<1	10	25	46
	(15-20 cm)	0.3	24	7	11,000	10	<1	10	25	34
	Garden	0.3	10	4	11,000	9	<1	6	23	34
4 (Res)	Lawn	<0.2	24	8	12,900	16	<1	9	26	54
6 (Res)	Lawn	0.5	41	18	16,000	26	<1	17	34	91
	(10-15 cm)	0.6	70	30	20,000	55	<1	34	60	134
9 (Res)	Lawn	0.4	24	13	8,150	24	<1	9	21	51
11 (Res)	Lawn	1.1	110	36	29,500	53	<1	44	79	180
	(10-15 cm)	<0.2	130	34	29,500	19	<1	50	83	106
	Garden	1.7	89	49	31,500	62	<1	38	60	220
12 (Park)	Lawn	0.6	110	31	29,500	17	<1	48	74	98
15 (Res)	Lawn	0.8	110	37	28,500	33	<1	46	70	140
	(10-15 cm)	0.7	115	39	29,500	27	<1	48	76	126
	Garden	0.7	105	36	29,500	22	<1	45	77	110
16 (Res)	Lawn	0.7	97	35	36,000	26	<1	43	73	104
	(10-15 cm)	0.6	110	36	29,000	17	<1	47	77	96
	(Garden)	1.3	30	35	13,000	106	<1	14	25	460
17 (Res)	Lawn	0.5	88	37	31,000	25	<1	40	65	93
18 (Res)	Lawn	0.6	95	38	32,500	40	<1	39	67	120
	(10-15 cm)	0.3	110	38	38,500	18	<1	47	74	98
	Garden	0.6	27	16	11,000	40	<1	10	24	130
19 (Res)	Lawn	0.3	62	22	20,600	20	<1	23	44	74
20 (Res)	Lawn	<0.2	63	30	24,000	27	<1	31	61	89
21 (Res)	Lawn	<0.2	24	8	11,600	13	<1	9	26	41
22 (Res)	Lawn	0.3	83	31	30,000	34	<1	39	67	118
	Garden	0.9	76	43	24,600	190	<1	33	65	296
23 (Res)	Lawn	0.2	42	15	16,000	89	<1	13	30	67
	(10-15 cm)	0.3	88	40	33,600	15	<1	46	68	87
24 (School)	Football Field	0.2	15	6	8,600	8	<1	6	19	28
	Baseball Field	0.5	41	22	16,600	31	<1	19	34	100
25 (Res)	Lawn	0.8	93	46	30,000	34	<1	43	62	168
	Garden	1.3	49	40	18,600	121	<1	23	38	220
26 (Res)	Lawn	0.9	105	40	38,500	37	<1	46	84	138
	(10-15 cm)	0.7	110	40	41,000	28	<1	48	80	110
	Garden	4.4	39	33	16,600	45	<1	17	34	111
27 (Res)	Lawn	0.4	23	14	13,000	33	<1	9	25	82
	Garden	0.6	26	21	14,000	47	<1	12	28	120
28 (Res)	Lawn	0.3	18	10	16,000	10	<1	7	21	63
	Garden	0.3	24	6	14,500	11	<1	8	31	34
29 (Res)	Lawn	0.4	27	14	13,600	34	<1	11	28	71
30 (Res)	Lawn	0.3	25	13	16,000	19	<1	16	33	64
31 (Res)	Lawn	0.7	88	41	36,000	30	<1	46	69	116
	Garden	<0.3	31	8	12,600	8	<1	15	28	34
32 (Res)	Lawn	0.9	110	41	33,600	45	<1	44	71	120
	(10-15 cm)	0.8	120	40	42,500	25	<1	53	80	120

Cont'd

Table 7 Cont'd

Site-Property	Area* Sampled	Average** Concentration in Soil (ppm, dry weight basis)								
		Cd	Cr	Cu	Fe	Pb	Mo	Ni	V	Zn
		Properties Sampled Remote from IVACO								
8 (Park)	Lawn	0.5	60	20	33,500	32	<1	33	80	74
	(10-15 cm)	0.5	83	24	31,500	31	<1	35	87	96
10 (Res)	Lawn	0.5	33	17	32,000	37	<1	14	39	69
39 (Res)	Lawn	<0.2	88	35	32,500	32	<1	40	71	97
	(10-15 cm)	<0.2	100	47	37,500	17	<1	45	103	98
	Garden	<0.2	15	8	10,500	8	<1	7	24	33
42 (Res)	Lawn	<0.2	39	22	30,500	32	<1	20	47	96
	Garden	<0.2	36	32	34,500	35	<1	16	47	110

Phytotoxicology Section Guidelines										
a ULN	Rural	3	50	60	35,000	150	3	50	70	500
	Urban	4	50	100	35,000	500	3	50	70	500
Soil D C b		4	1,000	200	-	500	5	200	250	900

* Where no sampling depth is shown, soil was collected at a depth of 0-5 cm with exception of garden soil. Garden soil was sampled at usual tilled depth (0-15 cm).

** Average of duplicate sample results.

[a] Phytotoxicology Section Upper Limit of Normal guidelines for surface soil (0-5 cm) in rural and urban areas.

[b] Phytotoxicology Section soil decommissioning or clean-up guidelines.

Note: Results underlined exceed the rural Upper Limit of Normal guideline for surface soil (0-5 cm)
Results with a double underline exceed the decommissioning guideline (e.g. Cd at Site 35).

RE2707-Tab7

TABLE 8
Metal Concentrations[a] (ppm., dry wt.)
Detected in Surface Soil (0-5 cm) in the Vicinity of IVACO since 1980.

Site* (Direction)	Cadmium			Chromium			Copper			Lead		
	1987	1984	1980	1987	1984	1980	1987	1984	1980	1987	1984	1980
4(W)	<0.2	<0.5	<0.5	24	19	16	8	6	6	16	12	12
1(N)	0.4	0.5	<0.5	25	64	52	9	28	42	21	32	30
6(NE)	0.5	<0.5	<0.5	41	34	25	15	15	16	36	32	25
9(E)	0.4	<0.5	<0.5	24	21	20	13	13	12	24	25	13
11(SSE)	1.1	1.0	<0.5	110	95	78	35	30	53	58	64	46
8(NE)	0.5	<0.5	<0.5	60	37	32	20	12	16	22	15	16
10(ESE)	0.5	<0.5	<0.5	33	20	24	17	15	17	37	33	30
ULN[b] R	3			50			60			150		
ULN[b] U	4			50			100			500		
Soil DG[c]	4			1,000			200			500		

Site* (Direction)	Nickel			Zinc			Iron		Molybdenum		Vanadium	
	1987	1984	1980	1987	1984	1980	1987	1984	1987	1984	1987	1984
4(W)	9	8	8	56	49	45	12,000	11,000	<1	<1	26	19
1(N)	10	28	33	46	95	106	12,000	25,500	<1	<1	25	44
6(NE)	17	15	14	91	80	103	16,000	15,000	<1	<1	34	28
9(E)	8	8	7	51	57	38	8,150	9,150	<1	<1	21	17
11(SSE)	44	37	49	180	180	160	35,500	35,000	<1	<1	79	66
8(NE)	25	16	17	74	57	61	23,500	18,500	<1	<1	50	33
10(ESE)	14	11	12	69	62	65	22,000	16,000	<1	<1	39	27
ULN[b] R	60			500			35,000		2		70	
ULN[b] U	60			500			35,000		3		70	
Soil DG[c]	200			800			-		5		250	

a Average of triplicate sample results in 1980 and of duplicate results in 1984 and 1987.
b Phytotoxicology Section Upper Limit of Normal guidelines for rural (R) and urban (U) surface soil (0-5cm)
c Soil decommissioning or clean-up guidelines established by the Phytotoxicology Section.
* Sites 1,4,6,9 and 11 were closest to IVACO with Sites 8 and 10 being more remote.

Note: Results underlined exceed the rural guideline for surface soil (0-5 cm).

TABLE 9
Metal Concentrations Detected in Field Soil (0-15 cm), Forage, and Corn Foliage Collected on Farm Properties in the Vicinity of IVACO and at Remote Sites - August 31 - September 2, 1987

Site	Sample Description	Average Concentration [a] (ppm., dry weight)								
		Cd	Cr	Cu	Fe	Pb	Mo	Ni	V	Zn
		Hay Fields Closest to IVACO								
31	Soil	0.7	92	35	36,500	31	<1	42	77	110
	Grass	<0.1	<1	4	95	2	<1	<1	<1	37
	Clover	<0.1	2	11	200	3	<1	1	<1	49
33	Grass	0.1	1	3	63	<2	<1	<1	<1	20
34	Soil	1.0	145	23	50,500	26	<1	60	103	180
	Grass	<0.1	2	4	72	<2	<1	<1	<1	23
35	Soil	1.1	120	42	42,500	39	<1	51	86	175
	Grass	0.2	2	5	155	4	2	1	<1	52
	Clover	0.1	2	14	245	5	2	2	<1	72
36	Soil	0.5	120	42	41,500	22	<1	52	79	105
	Grass	<0.1	1	5	59	<2	<1	1	<1	23
38	Soil	<0.2	110	64	38,000	19	<1	47	74	115
	Grass	<0.1	1	4	95	1	<1	1	<1	28
	Clover	<0.1	1	10	135	<2	1	1	<1	37
		Hay Field Remote From IVACO								
37	Soil	0.3	110	45	35,500	21	<1	52	79	110
	Grass	<0.1	<1	3	41	<1	<1	<1	<1	19
	Clover	<0.1	<1	10	49	1	<1	1	<1	28
		Grain/Corn Fields Closest to IVACO								
13	Soil	0.6	120	32	38,000	22	<1	46	74	100
14	Soil	0.6	115	33	38,000	22	<1	48	77	96
40	Soil	0.4	56	33	35,500	24	<1	33	48	250
	Corn Foliage	<0.1	2	8	120	3	<1	<1	<1	36
		Corn Field Remote From IVACO								
41	Soil	<0.2	25	13	14,500	28	<1	10	27	71
	Corn Foliage	<0.1	<1	10	75	2	2	<1	<1	14
		Phytotoxicology Section Guidelines								
ULN*	Soil	3.0	50	60	35,000	150	2	60	70	500
	Grass	0.5	5	7	500	20	6	5	6	40
Soil DG**		4.0	1,000	200	-	500	5	200	250	800

a Average of duplicate sample results.
* Phytotoxicology Section Upper Limit of Normal guidelines for rural surface soil (0-5 cm) and grass.
** Phytotoxicology Section soil decommissioning or clean-up guidelines.
Note: Results underlined exceed the rural Upper Limit of Normal guideline.

Table 10:

Range of Dietary Mineral Levels Tolerable by Domestic Animals (Cattle, Sheep, Swine, Poultry, Horse, Rabbit)

Element	Concentration Range (ppm, dry wt.)*
Cd	0.5 - 3
Cr	50 - 3,000
Cu	25 - 800
Fe	500 - 3,000
Pb	3 - 30
Mo	5 - 500
Ni	50 - 300
V	10 - 50
Zn	300 - 1,000

*Maximum tolerable levels, continuous long-term consumption may have adverse effects.

References

Davis, R.D., Beckett, P.H.T. and Wollan, E. (1978), Critical levels of twenty potentially toxic elements in young spring barley. Plant and Soil 49: 395.

National Academy of Sciences (NAS) (1980). Mineral Tolerances of Domestic Animals. National Research Council (U.S.), NAS, Washington, D.C.

Figure 1: Approximate Location of Moss Bag Sites Established in May 1986.

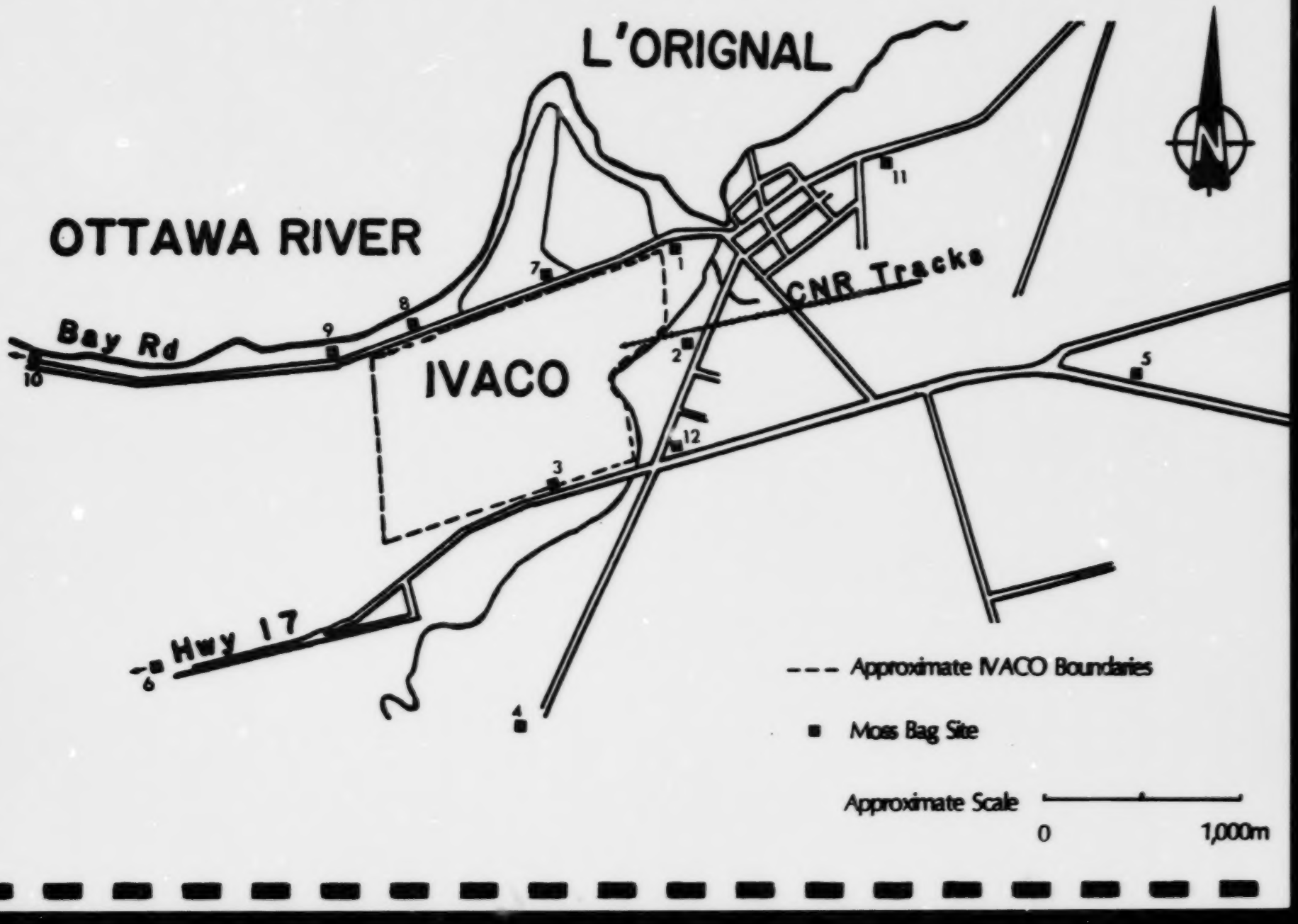

Figure 2 : Approximate Location of Residential and Farm Properties Sampled in 1987.